



Challenges Posed by Newly Elected Members

On October 11, 2003, the American Academy of Arts and Sciences welcomed its 223rd class of members at an Induction Ceremony in Cambridge, Massachusetts. Mathematician and computer scientist **Frank Thomson Leighton**, chemist **Carolyn R. Bertozzi**, lawyer and philanthropist **William H. Gates, Sr.**, and literary scholar and critic **Michael Wood** addressed the audience, which also featured a performance by world-renowned operatic baritone **Sherrill Milnes**. Their remarks appear below, in the order presented.



Frank Thomson Leighton

As a mathematician and computer scientist, I have been privileged to be a participant in one of the most important and exciting technological and sociological advances of our generation. I am speaking, of course, of the Internet.

As a graduate student at MIT twenty-something years ago, I remember thinking it was really cool to be able to type my thesis using a publication-quality word processor and then to be able to send it to colleagues across the country using something called e-mail. Back then, the network through which e-mail traveled was known as the DARPA Net, and it had been created to facilitate research collaborations among government, industry, and universities. Back then, only a few thousand people had access to this exciting new technology. Very few, if any, had any idea of its true potential or how it was destined to evolve.

Today hundreds of millions of people use the Internet on a regular basis to send e-mail, search for information, pay bills, buy books, get the news, make reservations, download music, run businesses, or just chat with friends. Trillions of dollars of e-commerce are conducted over the Internet annually. The Internet is even used to manage critical national infrastructure in sectors such as transportation,

banking, manufacturing, utilities, and national defense.

The power of the Internet as a communications medium is unprecedented in human history. Never before has it been possible for an individual or an entity to communicate with so many so easily and so quickly. The impact of the Internet on society will surely be a subject for study by future historians and sociologists.

The growth of the Internet infrastructure needed to support the myriad demands of hundreds of millions of users has been explosive. When I was a graduate student, the Internet consisted of a single network in a single country. Today the Internet consists of over fifteen thousand distinct networks that collectively span nearly every country in the world. The wires and fibers in these networks are connected, in a somewhat haphazard fashion, by millions of switches that process trillions of bits of data every second of every day.

In contrast to the growth of the Internet, the underlying algorithms, protocols, and software that make the Internet work have not changed all that much over the past twenty years. It is truly remarkable that the technology developed decades ago to support a single network used by a few thousand people has scaled to support thousands of interlinked networks used by hundreds of millions. It is even more remarkable that the original protocols have proved to be robust enough to support many unanticipated applications, not the least of which are the World Wide Web and peer-to-peer networks for file sharing. Some of the early pioneers of the Internet are members of this Academy, and they have made a tremendous contribution to society.

There are problems with the infrastructure, however, and these problems are now threatening to become critical. Several of the problems derive from the fact that the original Internet protocols were based on a foundation of trust. It was assumed that people would use the Internet for the purposes for which it was intended and that they would do nothing to harm the infrastructure or other users, either intentionally or by accident. There was a strong sense of community in which an individual user would not take actions to the detriment of the common good, even if such actions would directly benefit that individual.

While such noble assumptions were fairly safe in the collegial environment of the DARPA Net of twenty years ago, they have led to many of the vulnerabilities inherent in the Internet of today. Some of these vulnerabilities are well known. For example, who among us hasn't

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been inundated with spam or had our computer infected by a virus or worm? Unfortunately, spam and the few well-publicized worm-based attacks on the Internet infrastructure represent just the tip of the proverbial iceberg.

For example, it is well known that the famed Slammer worm that attacked the Internet earlier this year caused billions of dollars of damage and incapacitated several important networks. Slammer infected hundreds of thousands of computer servers within a few minutes of its release into the Internet. It is less well known that, despite all its damage, Slammer was a relatively benign worm in that it had no "payload." Slammer's only function was to replicate itself, and it was the mechanics of the replication that caused the damage. Had Slammer been specifically designed to cause damage, the outcome could have been far worse. And Slammer exploited just one of the thousands of vulnerabilities that are discovered in Internet-based software each year.

Other worms and viruses are more malevolent. In addition to using the infected computer as a host for self-replication, they also cause the computer to perform an Internet-based attack of some kind. For example, the Code Red virus was designed to attack the White House's Web infrastructure. The recent Blaster worm was designed to attack Microsoft's Web infrastructure. In other cases, the virus or worm acts as a Trojan horse, leaving the infected computer in a vulnerable state that can be exploited later in a manner, and at a time, chosen by the attacker.

The perpetrators of Slammer, Code Red, the original Blaster, and most every other virus and worm have not been caught. That is because the Internet protocols make it very easy to mask one's identity by stealing that of another. For example, before releasing an onslaught of unwanted e-mails into the Internet, a spammer will often hijack someone else's Internet identity and use that identity as the home base from which to send the spam. When investigators try to detect the source of the spam, they are led to an innocent bystander.

On the Internet, almost anyone can impersonate almost anyone else. Impersonation was never really contemplated when the DARPA-Net was designed, so no defenses were incorporated to prevent it. The implications go well beyond spam. For example, there are many ways for a thief to steal credit card numbers, personal passwords, and many other sensitive data that are commonly transmitted over the Internet. If a thief wants to learn the password to your online bank account, the thief simply directs your computer or your Internet service provider to send him or her all Web traffic destined for your bank. He can do this because it is relatively easy to trick a computer or the Internet into sending traffic to an unintended destination. When your browser contacts the thief instead of your bank, the thief responds by showing you the regular bank web pages that ultimately invite you to sign in with your password. You oblige, and the thief can now access your bank account without fear of detection. I don't know the precise figures on the amount of damage caused by e-crime annually, but it is a large and rapidly growing problem.

As the Internet assumes a more critical role in our national infrastructure, it becomes even more important that we address the vulnerabilities that have come along with the benefits. Today we worry about spam, viruses, and e-crime. Soon we will need to worry about the possibility that a government or a terrorist will use the Internet to attack critical infrastructure, with far more serious effects than an overflowing mailbox or a loss of money or confidentiality.

The challenge we face is to continue to reap the many benefits of a wonderful and remarkable technology while at the same time mitigating the impact of its misuse. This is, of course, not the first time that a technological advance has had the potential to be used for good as well as bad. In the case of the Internet, however, the challenge cuts across almost every sector of society. Governments must decide how use of the Internet will be regulated, if at all, and how liability for misuse will be assigned. Academics must discover novel ways to make the Internet more secure at the same rate as they discover novel ways to make the Internet do more cool things. Industry must work harder to identify and eliminate vulnerabilities before they are exploited. And each of the hundreds of millions of Internet users must themselves take greater care to prevent their computers from being compromised and used for destructive purposes.

I can't help but think, given the diverse and extraordinary collection of talent represented

here today, that the Academy itself might provide an ideal forum within which we can discuss and confront this important challenge. With everything that has already happened with the Internet, it is sometimes hard to remember that this is just the beginning. Many exciting discoveries lie ahead. If the experiences of the past few years are any indication of things to come, it will surely be an interesting journey.



Carolyn R. Bertozzi

As a chemist who studies biological systems, I represent a rapidly growing group of interdisciplinary researchers who seek to understand biology at the level of atoms and molecules. We call ourselves chemical biologists.

I am also a movie buff. One of my all-time favorites is *The Fantastic Voyage*, a classic from the 1960s in which a group of scientists and their spacecraft were miniaturized for a journey through the human body – an "inner space" no less cosmic or mystical than the galaxies and nebulae of outer space. These lucky scientists directly witnessed the organs and tissues that sustain us; they literally navigated vital processes, such as breathing and digestion, that we take for granted every day. What would those scientists have seen if they could have been shrunk further, to the size of a single molecule traveling along the surface of a living cell?

Jonathan Swift is quoted as saying "Vision is the art of seeing things invisible." In the past decade or so, technologies derived from physics, engineering, and chemistry have revolutionized the biological sciences by bringing the invisible to light. During my own career, I have witnessed a dramatic convergence of the

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physical and biological sciences. Biology is now considered a frontier to be explored with technologies originating from quite different fields, including condensed matter physics, aerospace engineering, and even the semiconductor industry.

Two recent Nobel Prizes underscore the impact of physical techniques in the biological sciences: one in physics, for the superconducting magnets that made possible magnetic resonance imaging, and another in chemistry, for the X-ray crystallographic study of ion channels, the proteins that transduce electrical signals in the body. Other technologies have now made it possible to visualize single cells within a complex tissue, and even single molecules within living cells. Suddenly, we have the tools to visualize chemical changes in the brain during the formation of a memory, the moment of first contact between a virus and its victim, the moment of conception. What we have learned has revised our scientific thinking in radical ways, and has also reminded us that we are still only scratching at the surfaces of biological phenomena.

The ability to study single molecules in action has produced some particularly startling results. In the past, molecules could be studied only as a population; thus, it was unknown whether individual molecules within an ensemble could possess different properties despite their chemical identity. We now know that a population presents only an idealized, most probable version of reality. Single molecules can exist in different states from those of their neighbors and adopt improbable contortions that are essential for their functions. Proteins can be seen “breathing,” DNA “relaxing.” It turns out that individual molecules can have moods as different as those of individual human beings while retaining their molecular similarity.

My own work focuses on understanding the landscape of cell surfaces, which have turned out to be as variable as the terrain of our plan-

et. Cells communicate with each other by virtue of molecules displayed on their surfaces. Changes in those molecules can signify changes in the cell’s physiology, including the transformation to disease states such as cancer. We develop chemical technologies for probing the types of molecules a cell displays and for relandscape those cells whose surface molecules are antisocial and will promote disease. Some interesting avenues for diagnosis and treatment of cancer have come from this work.

Just as the cells in our body communicate via cell surface molecules, microbial pathogens such as bacteria and viruses can interpret our cell surface code and exploit those molecules to infect us. An example is *Mycobacterium tuberculosis*, the bacterium that causes TB and kills more people each year than any other single infectious agent. This bacterium attaches to sugar molecules found on the surfaces of lung cells, an event that initiates infection. By understanding the chemical details of those sugars, we are hoping to craft new approaches for treatment and prevention.

As the physical and chemical sciences lead us deeper into the details of biology, we must not lose sight of the larger world around us. In such a tumultuous time, it is an overwhelming privilege to be engaged in scientific discovery and in academic pursuits in general. However, we should not forget that academic settings permit the flexibility to pursue scientific problems of global significance. Many of these endeavors, such as anti-TB drug development, are not commercially viable in private industry. In choosing systems for basic research, global considerations should be part of the equation.

But fundamental scientific discovery – asking why and how – is not frivolous. Indeed, these questions represent the natural drive to make sense of our world. James Watson is quoted as saying, “We used to think our future was in the stars. Now we know it is in our genes.” As my colleague Dr. Kate Carroll has noted, many of the qualities that make us human, such as hope, faith, determination, and love, remain genetically unmappable and chemically undefined. Understanding the basis of humanity is an eternal challenge that crosses the disciplines of the arts and sciences. We should work hard to foster the spirit of exploration and discovery among young scholars and remind them that the mundane world visible to us now is just one face of a more complex, more elegant universe that we still have no means to sense. We should show them the frontier and then follow their vision.



William H. Gates, Sr.

I need to open with a qualifying note. While I am an officer of the Bill and Melinda Gates Foundation, my remarks here and elsewhere on the subject of estate taxation are made for myself and are in no way an expression by or for the foundation.

As you are likely aware, I have spoken out for the retention of the federal estate tax. I suppose some would wonder whether the repeal or retention of a tax that is currently only a modest part of total federal revenues merits discussion among the profound subjects that concern the membership of this organization. I suggest that the issues test some fundamental national axioms and merit the thoughtful interest of serious citizens.

I will speak to three elements of the argument: fiscal impact, the rectitude of a tax on assets passing to heirs, and progressivity.

Recently, the estate tax has contributed some \$30 billion, which amounts to about 1 percent of federal revenues. However, there is general agreement among folks involved in making financial forecasts that this tax will become a major element of federal revenue.

The growth of the wealth of our wealthiest citizens has been prodigious in recent years. It appears that if one assumes a modest economic growth rate of 2 percent between 1998 and 2052, some \$40.6 trillion will pass by inheritance; an assumption of a 4 percent growth rate will mean an aggregated inheritance of over \$130 trillion. These figures lead to an estimate, even allowing for increased exemption amounts, of annual average federal estate tax collections of \$157 billion using the lower growth rate and of \$752 billion using the higher rate.

One cannot help but wonder at the thinking that argues to forfeit this huge revenue stream at a time when the nation is accepting an an-

nual federal deficit in excess of \$400 billion. The word reckless comes to my mind.

At the same time, one cannot help wondering from where and from whom this revenue will come if this tax is repealed.

A central criticism of the estate tax is the view of many that anyone who works hard and saves should be able to leave the results of his labor to his family. As one irate caller to a talk show shouted, “What right has the government to steal the money a man has worked hard to earn and save and which he wants to leave to his family?”

Is there propriety in applying the taxing power to a transfer from parent to child? My response is simple: more harm than good arises from large inheritances.

Can there be a serious question about the rectitude of our society's recovering from its most successful citizens a significant fraction of the fortune they leave at the time of their death?

Do we not see that so very often, the reliance on a large inheritance is a disadvantage to an heir, who is deprived of any motivation to make a constructive contribution?

“Wait!” cry the repealers. “This tax destroys parents’ motivation to work hard for the benefit of their kids.”

To which those of us who want to keep this tax say, “Not true.” We have had this tax for nearly one hundred years, and there is no evidence whatsoever that it has diminished the urge of our ambitious fellow citizens to create wealth.

Looking closer at this issue, few would argue for eliminating all family inheritance. Even those of us who like the tax acknowledge that at bottom, this debate turns on the question of how much should go to taxes and how much to kids.

Any examination of a policy that turns on quantity requires getting some numbers on the table. One can argue endlessly about what size estate should be exempt and what the rate of tax should be. I suggest that it is sensible to look at where the present legislation is taking us. In 2009 the exempt amount will have gone

up to \$3.5 million per person – \$7 million per couple – and the rate of tax will have come down to 45 percent. This is a reasonable set of numbers by which to look at the result in dollars. Here is how that formula would apply in a family:

Estate	Amount of Tax	Rate of Tax	To Heirs
\$7M	0	0%	7M
\$10M	\$1.35M	13.5%	\$8.65M
\$20M	\$5.85M	29%	\$14.15M
\$50M	\$19.35M	39%	\$30.65M
\$100M	\$41.85M	42%	\$58.15M

Are these remainder figures not enough? One response is that they are too much. Some critics of inherited wealth point out that there are two fundamental goals for an organized society in respect to economic affairs: (1) creating and protecting a system in which individuals can prosper and (2) making opportunity equal for all. They go on to point out what a great job we in this country have done in respect to goal number one but how dramatically we have failed at goal number two.

Moving on from the family inheritance issue, we need to look at the fairness of a tax that applies to so few of our people – only 2 percent of all those who die in any year, under the present rules. As exemptions increase, it seems clear that the percent paying the tax will get smaller. This is certainly the most progressive tax anywhere. Can it be justified?

Focus on the folks at the \$100 million level and up – people whose executors are going to have to write really big checks. We need to analyze just how you explain such a phenomenal accumulation of money.

No doubt the search for cause would disclose intelligence and hard work. But a deeper look would also disclose another fundamental factor: being born in the United States – what Warren Buffett refers to as winning the game of ovarian roulette.

What is so special about place of birth? First off, economists agree that the presence of a stable market for goods and assets adds 30 percent to the value of everything. We have that.

Who is the biggest venture capitalist in the history of the universe? No, he does not have an address on Sand Hill Road. He is a fellow widely known as Uncle Sam, and he spends some

\$96 billion every year on fundamental research in universities and laboratories all over this country. And what comes of this research? Well, for starters, how about things like integrated circuits, silicon microprocessors, the human genome analysis, the Internet – research results that are readily available to our smart entrepreneur.

Experts calculate that this basic research generates a 66 percent return. As Lester Thurow says, “Put simply, the payoff from social investment in basic research is as clear as anything is ever going to be in economics.” Another multiplier: economists tell us that 50 percent of the annual growth in our economy is a function of the introduction of new technology.

So, again, how do people manage to get so rich in this country? It is because the laws protect and the markets maximize value, and our science and technology keep producing new products and ways to get things done. The existence of a working and stable market, and a government continuously and gratuitously injecting new and useful science – topped off with a work force of ingenious graduates from educations subsidized by our government – has produced an economy that is uniquely innovative and robust.

The beneficiaries are not just the technology entrepreneurs – oh, no. The effects accrue to the building contractor, to the owner of a string of grocery stores, to the Wall Street broker – to all who seek wealth.

Again, why is our hundred-million-dollar millionaire so rich? Item number one: he is an American. Warren Buffett says it, as usual, so very well:

I personally think that society is responsible for a very significant percentage of what I've earned. If you stick me down in the middle of Bangladesh or Peru or someplace, you'll find out how much this talent is going to produce in the wrong kind of soil. I will be struggling thirty years later. I work in a market system that happens to reward what I do very well – disproportionately well.

Can there be a serious question about the rectitude of our society's recovering from its most successful citizens a significant fraction of the fortune they leave at the time of their death? This society has made it possible for these men and women and their families to have an elegant life: first-class education, comfort, virtually unlimited options about where to go and what to do, public acclaim. Society has a just claim, and it goes by the name estate tax.



Michael Wood

There is a young man in Martin Scorsese's film *Goodfellas* who says, "As far back as I can remember, I always wanted to be a gangster." As far back as I can remember, I always wondered just what it is that literature does, even if most of the time I merely surrendered myself to the enjoyment of whatever it was that it was doing. My few words here today are an attempt to say something about what literature does and why we need it now more than ever. We always need it now more than ever, whenever now is.

A little more than four hundred years ago, in England, Philip Sidney wrote "An Apology for Poetry" to defend literature against its enemies. He called it poetry, but he meant pretty much what we now mean by literature: imitations of life, with imaginary people doing real things, real people doing imaginary things, and, more rarely, imaginary people doing imaginary things. Poetry, Sidney argued, is more philosophical than history and more historical than philosophy. It is neither too concrete and particular nor too abstract and general, but just right, like a certain famous bowl of porridge, although that was not Sidney's comparison.

Sidney was being playful, so we should not take his aspersions on philosophy and history too literally. He was completely serious, however, in his belief in the value of poetry, and he was anxious to distinguish it from what he called "tougher knowledges." This is one phrase among many that make his old text seem so close to us. We too have our tougher knowledges and our more tender knowledges, although the words we most frequently use are hard and soft. Here is the question I want to propose for your consideration, and to answer partially: How soft is soft knowledge? Is soft knowledge really knowledge at all? Maybe if it's soft it isn't knowledge.

A colleague of mine, looking hard at a great modern painting – a vast abstract canvas by Barnett Newman – thought our usual critical demands were the wrong ones. What does this painting mean, what does it represent, what is it trying to say? These questions, he felt, were getting us nowhere. The question he wanted to ask was, What does this painting know?

This question has two immediate and very interesting implications: first, that a painting might know something that the painter didn't, and second, that the painting probably knows a lot that it is not going to tell us. Now, it seems as if literature – plays, poems, novels, essays – must tell us what it knows because, after all, it can talk, as painting can't. But I think exactly the same question can be addressed to a work of literature, and to good effect. Words speak, but words have their silences too, in ordinary life as in literature.

It's possible that the forms of the sonnet and the villanelle know something – about love, loss, repetition, design, language, memory, longing – that the individual writers of sonnets and villanelles may not know, or that the forms know these things differently. It's certain that F. Scott Fitzgerald's later short stories knew more about the divided contents of his mind than Fitzgerald did. There is much to say on this score, but today I'd like to concentrate on the other implication of the question. What does this work – play, poem, novel, essay – know that it is not telling us?

Of course the knowledge, told and not told, is going to be different in each individual case, and there is a sense in which we can't generalize about it. But we can generalize about the notion of the not-told – the residue of knowledge that we sense to be in a work but that is not made explicit. This tightens the screw of our question, because we are now asking not only if soft knowledge is real knowledge but also what silent knowledge means to us. If one opposite of soft is hard, the other is loud.

Literature – that is, both literary works and the study of literature – is often thought to specialize in doubt; even the dogmatic Bertolt Brecht thought of himself as a "teacher of doubt." Why do we think this? Because literature is all about imagining alternatives, other lives, other places – "the always possible other case," as Henry James put it. And doubt is important to literature, no doubt about it – but only because it is important to all forms of learning and understanding. Without doubt there is no knowledge. More specifically, there is no sustained knowledge without sustained doubt. So it can't be that literature really does more doubting

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than any other discipline or does nothing but doubt. That would not be soft or tender knowledge; it wouldn't be knowledge at all.

No, the point of imagining other people and other circumstances is not to dismiss or lose from sight the present people and circumstances, and it is not to scramble the boundaries between fact and fiction – although critics and scholars have been known to do those things. The point is to know what is the case and what could be the case, and to know both of these instances intimately: the first because we don't have a choice, and the second because we are willing to imagine it and keep on doing so – well, more than imagine it. Literature is the practice of living with what could be the case – really living with it because it occupies your mind and your heart; it takes up your energies and sympathies.

Is this knowledge? It is not secure knowledge, because part of the discipline of living with what could be the case is the steady consciousness that there could always be another case – another other case. But I do want to suggest that this very consciousness is a discipline or can be, and it is not an easy slipping from one option to the next. Every story has a story it is not telling, and if we listen, we can hear it in the silence. Not only can we guess what it means; we can also know what it knows. We can hear the kindness in the anger, the generosity in the rage, the certainty in the doubt, and the hope in the very articulations of despair.

This is not all that literature knows, but it knows and teaches this well. The great critic William Empson, moving easily from literature to ordinary life, once wrote of "a generous scepticism which can believe at once that people are and are not guilty" as "a very normal and essential method." "This sort of contradiction," he said, "is at once understood in literature. People, often, cannot have done both of two things, but they must have been in some way prepared to have done either; whichever they did, they will have still lingering in their minds the way they would have preserved their self-respect if they had acted differently; they

are only to be understood by bearing both possibilities in mind.” Transposing this thought to my theme, I would say that we need to hear, both for ourselves and for others, the story that is being told and the story that is not being told, because we shan’t understand anything if we don’t.



Sherrill Milnes

Sherrill Milnes preceded his remarks with a performance of “Surely the Presence of the Lord Is in This Place” by Lanny Wolfe, and Aaron Copland’s arrangement of the old American song “At the River.”

Singing does send a certain message – especially those two beautiful pieces – but I do have a little story, if you will permit me to both sing and speak. I have a relationship, in a strange way, to the Academy; you will see what I mean at the end of the story.

My maternal third great-grandfather, Matthew Lyon, was born in Wicklow, Ireland, in 1747. When he was thirteen, he stowed away on a ship bound for somewhere in this area of the United States, not necessarily Boston. He was discovered before the end of the trip, and the captain sold him as an indentured servant for three years in Litchfield, Connecticut.

Time passed. He found his way to the Green Mountain Boys and served with Ethan Allen all through our Revolutionary War. He was in the battle when we took Fort Ticonderoga back from the British. In 1797 he was elected to Congress as the sole representative from Vermont and served until 1801. He never lost his Irish mouth; he was a rabble-rouser.

I recently finished the book *John Adams* by David McCullough, which is a wonderful tome – very thick, but fascinating reading. As far as I knew, nothing in the book had any relationship to me – I was simply enjoying it and learning more about our country. All of a sudden, I found myself reading that my third great-grandfather, Matthew Lyon – on the floor of the hall in Philadelphia where Congress was holding its meetings – spit in somebody’s face

for criticizing his politics. Lyon was an anti-Federalist. There were two parties then, the Federalists and the anti-Federalist Jeffersonian Republicans.

At any rate, there was a newly passed sedition act at the time, which was duly repealed some years later – and Matthew Lyon was the first person to be indicted under that law. As McCullough notes, “He spent four months in a foul Vermont jail.” His friends paid a thousand-dollar fine, which was heavy back then. Somehow, he emerged out of jail as more of a national hero and was immediately reelected to Congress. And perhaps to get even – not with John Adams personally, but with John Adams as the head of a party or the head of the country – Matthew Lyon cast one of the deciding votes that put Thomas Jefferson in office; poor John Adams served only one term. As you will recall, it was the only time in American history when the vice president ran against the president, because they were not of the same party.

I am not sure how Matthew Lyon would feel about me being inducted into this Academy founded by John Adams, among others – but this third great-grandson is extremely thrilled and extremely honored. ■

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Academy Membership Profile

Current membership:

3,808 Fellows from 46 states

560 Foreign Honorary Members from 36 countries

The membership is drawn from 172 colleges and universities, 143 educational and research institutions, 74 cultural and artistic organizations, 171 businesses and corporations, 34 foundations and charitable organizations, and 14 government agencies.

Class of 2003:

181 Fellows from 22 states

29 Foreign Honorary Members from 9 countries

The new class is drawn from 146 colleges and universities, 17 educational and research institutions, 16 businesses and corporations, 3 foundations and charitable organizations, and 3 government agencies.